Automatic Image Scaling

Overview

Automatic Image Scaling is a feature that allows pixel-mapped images to be enlarged or reduced to optimize their size to the page. When combined with the printer's automatic image rotation feature, scaling allows images to be printed as large as possible on the paper. You may print an image either scaled or unscaled by selecting the appropriate Logical Device, as you wish. Image scaling is also configurable, allowing you to choose between several advanced algorithms, based on individual detail, clarity, and speed requirements.

Background

Most computer images are stored as fixed collections of color dots or "pixels". These images are known as "pixel-mapped" or raster images. The printer also has a fixed resolution that provides 2400 x 2680 pixels on a page (for A-size media). Most raster images are not this exact size. Without image scaling, most images would either print too small on the paper or else be cropped at the edges if they are larger than the printable area of the page.

To overcome this problem, the printer provides the ability to print images with and without the automatic scaling feature enabled. On the printer these facilities are known as Logical Devices. Device 1 is known as the Unscaled Device and Device 2 is known as the Scaled Device. The Scaled Device will automatically calculate how much to enlarge or reduce the image so a maximum size image is produced without being cropped or distorted. The image may be sent using the FTP or LPR programs. For information on printing using these programs, please refer to the appropriate Technical Briefs.

Choosing the Right Scaling Algorithm

The printer offers a choice of five different scaling algorithms. Each algorithm has unique traits that make it appropriate for different types of images and applications. Some techniques require more processing time than others. The following is a list of scaling algorithms provided by the printer. In general they are presented in order of increasing complexity and increasing processing time.

Box

Box scaling is the fastest of the scaling algorithms. It is implemented using pixel replication. Box should be used for images containing text with block letters in which the text must remain sharp.

Artifacts: Box tends to produce blocky-looking prints, especially when large scale factors are used.

Bilinear

Bilinear scaling is the second-fastest scaling routine and is the **default setting** on the printer. It employs linear interpolation to determine the output image. Bilinear scaling provides very good scaling for most applications where scale factors are relatively small (4X or less). A great amount of optimization effort was put into the bilinear algorithm.

Artifacts: Block letters will have fuzzy edges. Bilinear results in a slight decrease in dynamic range for large scale factors.

Mitchell

Mitchell is the best scaling algorithm of the printer. It uses a cubic Mitchell function to produce very smooth output while maintaining dynamic range and sharpness. Mitchell scaling takes approximately twice the processing time as Bilinear. Mitchell can be used for any scaling application, especially when scaling factors are 2X or greater.

Artifacts: Block letters will have fuzzy edges.

Bicubic

The Bicubic algorithm produces the smoothest output, but tends to smooth over fine details. The filter function is a cubic B-spline filter. This routine requires the same processing time as Mitchell. Bicubic is recommended for applications where the smoothest output is required.

Artifacts: Images may appear somewhat blurry due to the smoothing of the filter. Block letters will have fuzzy edges.

Lanczos

Lanczos uses a filter based on the sinc function. This is the most theoretically correct filter and produces the best output for photographic images that do not have sharp transitions in them. However, Lanczos will produce ripple artifacts especially for block text, due to aliasing. Lanczos also requires three times the processing time of Bilinear. Lanczos is not recommended except in very rare applications using band-limited photographic images with no sharp edges.

Artifacts: Lanczos produces ripple artifacts around sharp edges, such as found with text. This algorithm is not recommended for most applications.

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Setting the Scaling Technique

The printer scaling method can be adjusted two ways. First, the printer default value may be set from the printer's front panel. Secondly, users may set their individual scaling preference on the printer by sending a text file to Logical Device 0. These two methods are summarized on the next page.

Setting Printer Default Scaling Method

Setting the scaling method through the printer's front panel specifies the **printer default value**. This value is used for any users who have not stored a personal settings file on the printer. This value is entered into the printer as follows:

Use the following front panel key sequences to select the Scaling Method. When an **<Up-arrow>** or **<Down-arrow>** is indicated, press the key repeatedly until the correct response is showing on the LCD. Start from the READY display.

Use Key	Until LCD Displays
<Setup>	SETUP: NETWORK
<Down-arrow>	SETUP: IMAGE
<Setup>	IMAGE: TCR
<Down-arrow>	IMAGE: SCALING
<Setup>	*The LCD will display the current Scaling Method.*

To change the Scaling Method, use the following front panel commands:

<Up-arrow> *or* **<Down-arrow>**	*Until the desired Scaling Method is shown on the LCD.*

Once the desired Scaling Method is displayed, exit from the setup menu and return to the READY *state as follows:*

<Setup>	IMAGE: SCALING
<Down-arrow>	IMAGE: EXIT
<Setup>	READY

Setting Personal Scaling Method

Users may store a file on the printer specifying their personal image processing preferences. The file must be a plain text file. To specify the scaling method, first create a file with the following text:

> **SCALE** *method*

Where *method* is one of the following: **BOX**, **BILINEAR**, **MITCHELL**, **BICUBIC**, or **LANCZOS**. Send the text file to Logical Device 0 of the printer using the FTP or LPR programs. The user must be logged in under his/her own username for LPR and must use their own username and binary transfer mode when using FTP.

Note: The text file is stored on the printer and is referred to any time that user makes a print. **If the user previously stored a personal settings file on the printer, this will overwrite the original.** Therefore, all other personal preferences should be included in this file, as well. An invalid file sent to Logical Device 0 will clear any existing file which would return all settings to factory defaults.

Querying Printer Status

The printer default scaling algorithm can be determined by querying the front panel as described in the previous section. The printer default and user-specific settings can also be determined using the **root** login from a Telnet session and running the **stat** command. Users that are familiar with Telnet can log into the printer as follows:

1. Telnet to printer's **hostname** or **IP Address**
2. Login as **root**
3. Run **stat** *username* command.

This command displays a page of useful information about the printer status. All of the image processing options for both **root** (printer default settings) and the specific **username** are displayed.

Theory Behind Scaling Algorithms

Automatic Image Scaling treats the rows and columns of the image as discrete time-domain signals. These signals are a sampled version of the original analog image and have an inherent sample rate that results in a fixed number of pixels in the image. To rescale the image, it must be resampled at some new, predetermined rate to provide the desired number of pixels that will fill the page.

This is done by convolving the rows and columns of the original image with various low-pass filter functions to provide sample values at each of the output image pixel locations. With image reduction, the cutoff frequencies of the filter functions are reduced so that aliasing is not introduced. Scaling is performed in two passes. First, the rows are rescaled, then these rows are used for rescaling the columns.

The different filter functions have been carefully selected to provide a range of options that draw a balance between smoothness, detail, accuracy, and processing speed.

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